anxious to get together all the curious and striking forms he could, and his collections of Orthoptera, Hymenoptera, and Hemiptera were probably among the most extensive known.

Throughout his life he made copious notes and drawings of any natural curiosities that came under his notice, and kept a regular record of the rainfall and other meteorological occurrences. The care of all his collections, &c., occupied so much of his time that he had little left to devote to literary work, but he always allowed free access to the collections to any who were working and might benefit from them. At Reigate he started the Reigate Natural History Club, of which he was president for many years, and which still flourishes.

He left Reigate on account of business difficulties in 1873, and his collections were sold and dispersed. He then went to Worthing, where he resided till his death, having again surrounded himself with all the interesting plants, insects, &c., that he could get together.

TAILS[1]

II.

ANOTHER animal, the tail of which is remarkable for its mass of hairy covering, is the great ant-eater. But much more renowned is the yak, the tail of which animal is carried before dignitaries in Central Asia as an ensign of honour.

Such, then, are some of the main peculiarities of the tail in beasts. It is generally long, but may be absent altogether. It is generally hairy, sometimes very hairy, but it may be naked. It attains a prodigious size in exclusively aquatic forms, and in less aquatic forms—like the otter—it is largely developed, and somewhat flattened laterally, to aid the body in swimming.

Let us now consider the tail of a bird, and contrast it with that of a beast.

Every one knows that many birds are spoken of as having long tails, and so they have, in a sense. But a glance at the skeleton shows that it is not in the *same sense* that a bird and a beast are said to be "long-tailed." The bones of a bird's tail are few in number, and short, so that the tail is always very short as regards its bony portion, and also as regards the muscle and skin which covers it. At its end is a more or less conical or "plough-share-shaped" bone, made of several vertebræ, which have coalesced together. Into the skin, which invests this short tail, are set the more or less long tail feathers, which form what we ordinarily call "the tail" of a bird. On the upper surface of the fleshy tail birds also carry a sort of natural pomatum-pot. It is a grease-secreting gland, especially developed in water-birds, which may constantly be observed rubbing their bills first upon this region and afterwards over the feathers of their body, in order to give them a coating of this natural unguent. It is the presence of a good supply of this coating which renders the feathers of aquatic birds so impervious to water as to cause it to be thrown off with a readiness which has given rise to the familiar saying "like water off a duck's back."

All birds without exception which now live, have but a short tail—in the true sense of the word—however long may be the *feathers* which clothe that tail. But it was not always so. A very ancient fossil bird has been (a few years ago) discovered in the Solenhofen slate of Germany. This fossil proves that in the secondary period, birds existed quite like our present birds in general appearance, and in the main details of their structure, but with a tail formed of a number of vertebræ of considerable length, like the tail-vertebræ of a long-tailed beast or (as we shall see) lizard. On each side of this tail were set feathers, so that altogether the structure was like nothing which is to be seen in the world about us to-day.

[1] A Davis lecture recently delivered at the Zoological Gardens by Prof. St. George Mivart, F.R.S., V.P.Z.S. Continued from p. 512.

This bird was the renowned *Archeopteryx*.

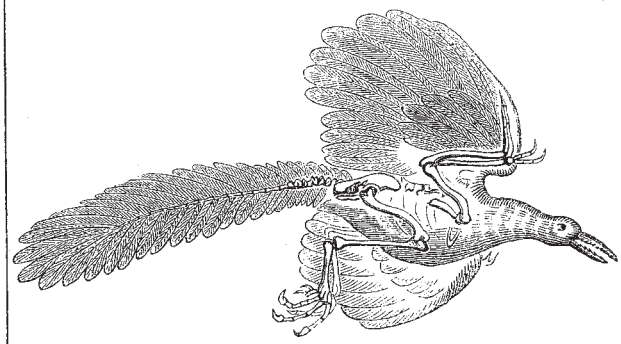

FIG. 5.—The Archeopteryx (of the Oolite strata).

But apart from such old-world wonders as this, what we call a bird's "tail"—meaning thereby the long feathers of the hinder part of its body—does not always denote really the same part.

The true "tail" of a bird (in this sense) means the collection of more or less strong and more or less elongated feathers which are implanted into the skin investing its short bony tail.

Of this nature is the tail of an eagle, of an ostrich, and the longest of all such tails—the enormous tail of the beautiful Reeve's pheasant. You will naturally wonder why I do not include that most wonderful and magnificent object, the "tail" of a peacock. I do not include it for the simple reason that this so-called "tail" is not a tail. Not a "tail" in the sense of a beast's tail, or that of the archeopteryx; not a "tail" in the sense of an ordinary bird's tail, *i.e.*, it is not made of feathers implanted into the short fleshy tail.

The feathers of birds are classed by ornithologists in different groups according to their position on the body, and to each such group is given its own special name. Thus the long feathers implanted into the side of the arm and hand (by which long feathers birds fly) are called naturally "wing-feathers," but there are other feathers implanted in the body at the root of the arm, and which so lie that they cover over and protect the roots of the wing-feathers. These root, or covering, feathers, which are comparatively short feathers, are called *wing-coverts*. Just in the same way, there are ordinarily short feathers implanted in the hinder part of the body, which short feathers cover and protect the roots of the tail feathers. They are therefore called *tail-coverts*.

Now the magnificent plumes of the peacock are not tail feathers, they are *tail coverts*, enormously enlarged and greatly exceeding in size the true tail feathers.

You may have observed a peacock setting up its so-called tail; if not, take the next opportunity of observing it. You will see that these very long and delicate plumes are lifted up and sustained by means of certain short and stiff feathers, and if you get behind the animal, you will see these latter feathers, which can be erected and so prop up and support the great mass of long, radiating tail-coverts. These short, rigid feathers are the true tail feathers, and thus in truth the peacock has a short tail, not only as regards the skeleton, but also as regards the true tail-feathers, in spite of the length of that magnificent appendage which usage will force us still to call the peacock's "tail," even after we have made acquaintance with its real nature. Indeed it would be a piece of pedantry to call it anything else; but yet we may bear in mind, when we do call it tail, that we do not here denote by that word the same structure as we denote when we speak of the "tail" of ordinary birds.

This condition is not peculiar to the peacock, though it is the most striking instance of it. In such kinds as the grouse the tail is in large part formed by tail-coverts.

© 1879 Nature Publishing Group

The "tail" of the lyre bird, on the other hand (the "lyre" being formed by the external thick and gracefully curved feathers, with delicate string-like feathers between) is a true tail, and its feathers are implanted around its bony tail.

It may be mentioned in passing that we sometimes meet with an analogous elongation of feathers of other parts of the body which are usually short. The beautiful and delicate plumes of the ordinary birds of paradise—those "crows" of Eden, for they are only kinds of crows after all—are made of exceedingly elongated axillary feathers, which in length greatly exceed the wings themselves.

To return, however, from wings to tails: the tails of birds, whether long or short, or whatever their nature, never serve the purpose which the tail serves in many beasts, and which we shall hereafter find reason to think was the very original purpose of "tails" when they first came into the world.

No bird swims by its tail. Birds, such as swans and ducks, swim by the paddling action of their feet. The most aquatic of all birds, the penguins, swim by the strokes of their wings, clothed with scale-like feathers—for the penguins may be said to fly under water. Whether any ancient aquatic bird once existed with a long tail like the archeopteryx is doubtful, but if it did, it is hardly likely that such an organ acted as a swimming organ. For to be able so to act, it must have been muscular, and therefore both thick and heavy, and therefore a fatal encumbrance to a creature destined for flight. If it were so furnished, and was destined never to fly, but to paddle like a penguin, in addition to propelling itself by lateral or vertical blows of a long and thick tail, then such a bird would be one difficult indeed for us to picture to our imaginations—though of course not outside the bounds of possible existence.

Let us now pass from considering the tails of birds, to a review of the tails of reptiles. In this matter we find a return to conditions we have made acquaintance with in beasts.

All living birds have tails which, as regards their bones, flesh, and skin, are nearly alike, but reptiles (like beasts) may have tails which are either long or short, according to their kind. We also here again meet with a "prehensile tail" like that of the kinkajou, or spider monkey. We find such a prehensile tail in the chameleon.

The chameleon is a creature destined to live on trees, and has its hands and feet modified into so many two-pronged grasping organs, to take a sure hold of the twigs and branches. It is a very slow animal, exceedingly deliberate in its motions, and did its hold partly fail, it would be incapable of rapid and sudden movements to save itself from falling, by a sudden clutch at some new point of support. Accordingly, it has an extra chance given it by its tail, which, tightly grasping by its curled end, gives the animal the advantage of what is practically a fifth limb.

Strange to say, though, it is not quite every kind of chameleon thus provided. There are many known kinds, and all but one have prehensile tails. One kind, however, not long ago described by Dr. Günther in the *Proceedings* of the Zoological Society, has a short tail, altogether destitute of any power of grasping. The tail, therefore, is useless to it as a prehensile organ, but instead it has, by way of compensation, serrated claws, which other chameleons have not.

The tail of the crocodile is a prodigiously powerful and very long one. It is thick, containing voluminous muscles, by the action of which this animal not only swims with facility, but when on land is able to deal terrible blows. Indeed lizards, with tails which are slender in comparison with the crocodile's tail, are yet able to deal powerful blows and to inflict whip-like cuts by means of lashing their long, rough-skinned tails. I am again indebted to Mr. Bartlett, for a note on this subject. He tells me that he found the large lizard called the Egyptian Monitor do this when lively and in full condition.

Most of my male hearers have, no doubt, when attempting to catch by their tails one of our little English lizards, been surprised to find the animal run away, leaving its tail behind in their grasp, and seeming none the worse for its sudden loss. The tail left behind will twitch and move about in a lively manner for a considerable time, especially on a very hot and sunny day.

This loss, which the animal so readily undergoes, is not, however, a permanent one. A new tail soon begins to sprout, and before very long an ordinary observer could not tell this new tail from the old one, although in the details of its structure it is not quite the same. The power of repair in these animals' tails may be shown in other ways. If the tail happen to be divided not transversely, but longitudinally, each such half will become an entire tail, when the process of reparation is complete; then, if each of the new tails be again longitudinally divided, each such new division will again become entire, and the process has been repeated till the lizard operated on came to have as many as sixteen tails, side by side.

The tails of lizards are most various in shape, although mostly long, and sometimes exceedingly so; there are what are called "stump-tailed lizards," as in the adjoining house at this moment. Some Australian lizards have short and flattened-out tails of exceedingly odd appearance, the utility of which it is hard to conjecture.

Snakes may, in spite of their always long bodies, have short tails, while in some kinds the tail is exceedingly long.

I have in this bottle a real "sea-serpent." Do not imagine, however, that it is the young of the renowned animal of our newspaper correspondents. That animal, if really any one animal at all serves as the foundation for these travellers' tales, cannot be a serpent. This creature, however, is a true sea-serpent—and a poisonous one to boot—and many such of various species are found in the waters of the Indian Ocean.

They exhibit a remarkable adaptation to their aquatic life, in that their tails are flattened laterally so as to fit them the better to serve as swimming organs, like the tails of fishes.

Some small serpents which burrow in the ground (*Typhlops*), and some legless lizards (*Amphisbæna*) of similar habits, have very short tails, while the two extremities of the body become strangely alike in appearance.

Other small burrowing serpents have the tail ending in a flattened disk, just for all the world as if a portion of it had been cleanly cut off and had then skinned over. The use of this structure is problematical.

My friend Dr. Günther writes to me on this subject:—"I have often thought of the use of the rough tail of the *Uropeltidæ*, and believe that it is used either for burrowing in the soil during a backward motion of the animal (like the roughness on the shell of some burrowing mollusks); or for affording to the animal, whilst it is burrowing in a forward direction, a firm support on the smooth surface of its burrow. It may be of use in both ways."

Most renowned of all serpents' tails, and justly so, is the tail of the rattlesnake. This organ consists of a thickening of the outermost skin (or *epidermis*) which invests the end part of the tail. The thickening takes the form of a series of rings, which encircle the tail, and of course diminish in size as they approach the tail's end. By a rapid vibration of the tail these thickened rings of horny substance (for epidermis has the nature of horn) strike one against another, and produce a very peculiar noise, which may occasionally be heard in our reptile-house, and is heard when the rattlesnake is alarmed or excited.

© 1879 Nature Publishing Group

Thus the "rattle" of the poisonous rattlesnake (like the expanding hood of the poisonous cobra) must tend to act as a warning to creatures exposed to its attack. It is very difficult to see what service this rattling can do to the rattlesnake itself. It has indeed been suggested that the sound resembles running water, and that in this way

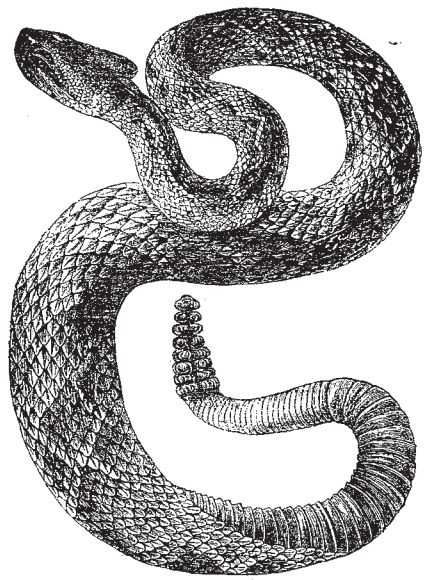

FIG. 6.—Tail of Rattlesnake.

creatures may be attracted to its vicinity. I must say that I for my own part have never been able to detect any such resemblance. Moreover, to have such an effect the rattling should be long-continued, whereas it is, in fact, kept up but for a short time, and is only produced at comparatively rare intervals.

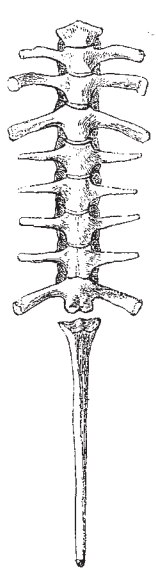

FIG. 7.—Backbone of the Frog (ventral aspect).

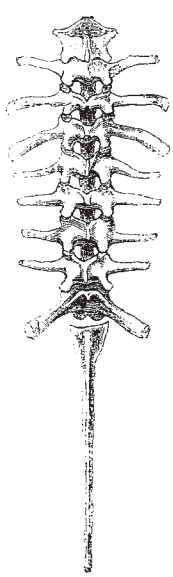

FIG. 8.—Backbone of the Frog (dorsal aspect).

Below the great group of reptiles is another group of animals, at one time associated with them, but now recognised as having a greater affinity with fishes. The group of animals I refer to is that which is made up of frogs and toads, together with efts (or newts), which latter are such familiar objects in our ponds in the spring of the year.

The efts have all long tails, but the frogs and toads are fully as destitute of a tail as we ourselves are, though they have a long slender bone at the hind end of their vertebral column, which bone reminds us of the plough-share-shaped bone of birds. But you may recollect that this tail-less condition, even in ourselves, does not obtain in the very earliest stage of the human body. In frogs and toads a "tailed" condition endures much longer; for these animals, as you know, pass the first part of their life entirely in the water as "tadpoles," swimming about entirely by the undulating action of their long "tails." The tadpole is at first a singular object. It consists of a head and body indistinguishably united in one rounded ball, from behind which a long and slender tail projects. The creature may be said to be indeed at first "all head and tail," for its head is relatively very large, and the heart and other organs may almost be said to be included within it.

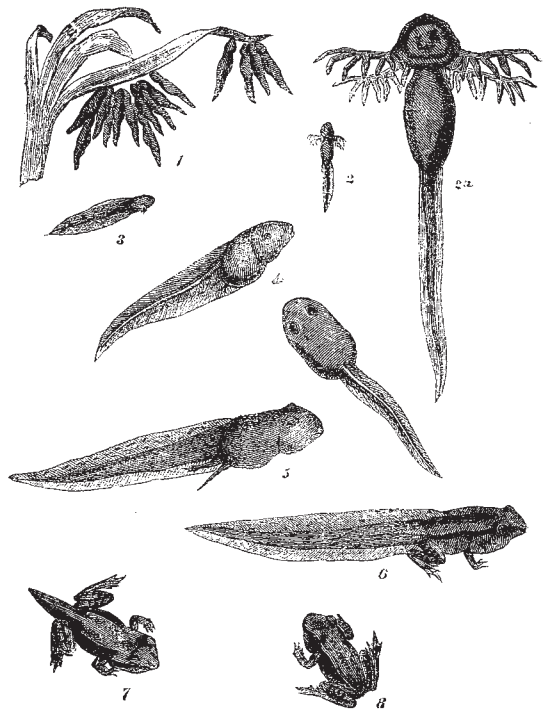

FIG. 9.—Tadpoles in different stages of development, from those just hatched (1) till the adult form is attained (8).

Whatever may be the best way, however, of regarding its head, there can be no doubt about its tail, its function, or its fate. It is, as I have said, a swimming-organ, but you know that as the tadpole becomes a frog or toad, it either comes on land or swims in quite another fashion from what it does as a tadpole, usually by striking out with its legs and feet, just as we swim, only it does it much better. Thus the tail becomes a superfluous appendage, and indeed as the limbs grow, the tail is gradually absorbed. It is not cast away! Our popular novelist was wrong in writing "What next! as the tadpole said when his tail dropped off;" it does not "drop off," but is sucked up by the creature's body gradually. Indeed the animal feeds upon its tail, not by turning round, biting, and eating it, but by its substance being gradually taken up and absorbed by the blood-vessels, and carried elsewhere, to assist the processes of bodily growth and development which are rapidly taking place.

Tadpoles and efts lead us naturally to the last and lowest class of backboned creatures the class of *Fishes*.

© 1879 Nature Publishing Group

As these animals are all aquatic, so they all have more or less long and powerful tails. Almost always they swim by striking the water right and left with the tail, and as they breathe by gills, without coming to the surface, so the tail and its hinder end are flattened from side to side, and not from above downwards, as we have seen to be the case with the air-breathing whales and porpoises.

Some fishes, however, progress largely by means of great lateral fins, as is the case with the rays, or skates, and in them the tail is comparatively small.

There are certain fishes which go by the name of *Sea Horses*, though they are but small creatures. These fishes swim through the water in a remarkable way. They appear as if they glided at will without effort. But there is on the back a small fin, which by its constant undulations acts like the screw of a screw-steamer. It is by this the creature moves, and the long tail takes no part in such progression, and is relatively thin and small, except as to its length.

In this tail, however, we find once more that prehensile character, such as we saw in the chameleon, the kinkajou, and others. The sea-horse anchors itself by clinging with its tail round sea-weed, or some similar object, much as do the animals mentioned.

The tails of fishes are like those of beasts and reptiles, supported by an extension of the back-bone, and, as a rule, contain no body-cavity. But the mode in which the vertebral column ends varies in different fishes in a way worthy a passing mention.

In such a fish as the sturgeon the end of the tail is furnished with a fin, divided into two unequal lobes. The end of the vertebral column runs along in the upper lobe, but there is nothing similar in the lower lobe, so that the lobes of the tail are very unequal, not only in size, but also in structure. The tail-fins of sharks are similarly conditioned. In such a fish as the cod-fish, on the other hand, the vertebral column seems to stop short in the middle between the two lobes of the tail, which lobes are equally developed.

This difference may seem trivial, but, in fact, it is characteristic, not only of different groups of fishes, but of fishes of different geological periods. The unequal tail end is the more ancient, and has gradually given place to the other apparently quite symmetrical form. I say apparently, because, in fact, when the symmetrically formed tail is minutely examined, it turns out that even here, the end of the vertebral column is turned up, extending dorsally as in the sturgeon and sharks. But it is only a minute portion which is thus turned up. However, it *is* turned up, and very strongly so, and thus the curious fact of the upward inclination of the tail is seen to be a general character of fishes, whether their tail-fins are apparently symmetrical or not.

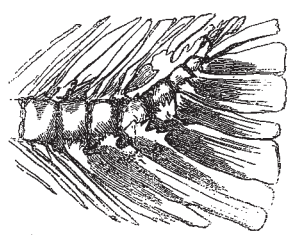

FIG. 10.—Post-axial termination of the vertebral column in a salmon.

Such are the main varieties of tail which are to be found in back-boned animals, that is to say, in beasts, birds, reptiles, frog-like creatures, and fishes; and thus we see that one general structure underlies the various varieties of external appearance which the tails of such creatures may present.

But there are many creatures of quite different nature and build, which are said to have "tails." Thus, for example, we speak of the "tail" of a lobster, or the "tail" of a scorpion.

Now, of course, I do not mean to assert here, any more than I asserted about the feathery so-called "tails" of birds, that you should depart from ordinary usage. Still, the so-called "tail" of such animals is really utterly unlike the tail of back-boned creatures, and is, in fact, but the backward prolongation of the body.

The lobster's body is made up of a series of more or less similar segments, in great part more or less agglutinated together. It contains a body-cavity which is traversed by the alimentary canal. The so-called "tail" does not differ from the lobster's body as the tail of a cat differs from the cat's body. For the tail of the lobster is also composed of a series of similar segments, also contains a body-cavity, and is also traversed for its whole length by the alimentary cavity—that is, by the intestine. The same is to be said with respect to the so-called "tail" of the scorpion, which, although so much more slender than the so-called tail of the lobster, is no more really a "tail" than is the latter.

We see, then, that the word tail in its proper signification means the prolongation backwards of a backbone (with the soft structures which surround it) beyond the body-cavity and behind the posterior end of the alimentary canal. This is the strictest meaning of the word "tail."

But other structures which, by their position, posterior extension, slenderness, or some other analogical resemblance, more or less resemble what is most properly and strictly called a tail, have the same term also applied to them.

While freely adopting popular usage in this matter, and calling, without scruple, by this term whatever is commonly and generally so termed, it is none the less well to bear in mind the differences which have been here pointed out as existing between the various more or less different structures which are thus spoken of by one common term.

The survey we have made has also another result. Different organs have not only their proper forms and structures, but also their proper uses.

The uses to which we have seen that tails are applied are more or less varied. Sometimes, indeed, the tail may serve as a fifth hand, as in the spider-monkey; but tails are generally related to locomotion, or at least to the balancing of the body, and prehensile tails are important aids to safe locomotion, especially in climbing.

But tails are most generally and largely developed in the class of fishes, and altogether the most effective aid to locomotion which tails offer is the aid they give in swimming. As, then, the essential structure of a tail is a backward prolongation of the vertebral column without any body-cavity, so the essential and fundamental *use* of a tail seems to be to act as a swimming organ. As the class of fishes seems to have been the first class of back-boned animals to come into existence, so we may deem it probable that a tail first appeared as a swimming organ added to a body in front of it, somewhat, perhaps, as we find the tail of our existing tadpoles.

This matter, however, is but one of speculation. But the world around us, as it exists now, affords us many examples of beautiful adaptation and utility in the structures in the examination of which we have been concerned to-day. The perfection of the hand, the varied adjustments of limbs, the wonderful complexity of the head, are matters for which every one would of course be fully prepared. But our survey may perhaps have sufficed to show that utility, beauty, and adaptation are exhibited to no small extent by organs the structures and functions of which are so rarely treated of and so slightly noticed as those with which we have been occupied, namely, the organs called "tails."

© 1879 Nature Publishing Group